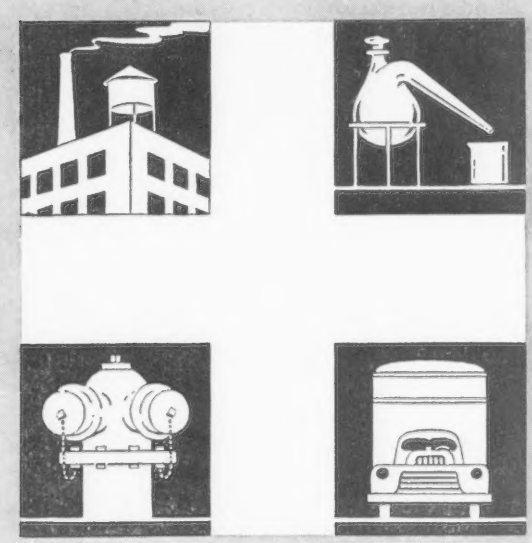
The Journal

OF THE AMERICAN SOCIETY OF SAFETY ENGINEERS



Volume V Number 4

IN THIS ISSUE

...President Speaks on Safety....49

...fe and Unsafe Use of Rupture Discs
...William W. Allison.....50

...goslavia Looks at Safety
...Philip J. Bailey.....53

...ppraising Safety Effectiveness
...John V. Grimaldi 57

...stracts 63

Five Journal Articles Win Technical Paper Awards

■ THE SECOND ANNUAL presentation of the co-sponsored Society-Veterans of Safety Technical Paper Awards was made October 18, 1960, at the Society's Awards Luncheon in Chicago. These awards, initiated last year to recognize accomplishment and to encourage members to prepare articles and submit them to the *Journal*, apparently have been successful in this latter purpose. In the 1959 competition, nine manuscripts were eligible for consideration and three were selected for honors. This year, 17 papers were considered by the judges and five received awards.

The *Journal* and its readers naturally profit from the increased number of papers being submitted for publication. High quality of the entries becomes evident as they appear in print. Of special interest, of course, are the 1960 winners, which are:

"The Personal Touch" by Robert D. Gidel (first place), to appear in the February, 1961, issue.

"Our Society Must Prepare Today for Tomorrow" by C. Russell DeReamer (second place), which appeared in the May, 1960, issue.

"Safe and Unsafe Use of Rupture Discs" by William W. Allison (honorable mention), *in this issue*.

"Safety—Its Relation to Cost and Production" by Albert L. Anthony (honorable mention), to appear in the February, 1961, issue.

"How Much Safety Factor?" by Robert F. Schoof (honorable mention), to appear in the February, 1961, issue.

We hope—and believe—that *Journal* readers will find as much of interest and value in these articles as has—*the Editor*.

AMERICAN SOCIETY OF SAFETY ENGINEERS

Organized 1911—Chartered 1915

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OUR PRESIDENT SPEAKS ON SAFETY

IT IS WITH HUMILITY that I accept the honor of the presidency of the American Society of Safety Engineers. By electing me to this office, the membership has indicated confidence in me to lead our Society toward its stated objectives. I assure you that whatever my actions or decisions may be during my term of office, they will be motivated by a sincere desire to benefit the Society.

I don't have to tell you that the act of becoming the president of this Society is accomplished in an entirely different manner from that of attaining the presidency of the country! Since you have not had the benefit of my views as you would had I run for a political office, I feel obligated to outline my philosophy relative to the purposes of the Society and membership in it.

It is my conviction that the Society's most important objective—its primary reason for existence—is to enhance the stature of the Society, its members and our profession—to create and advance a "professional image" which will command an increasing recognition of and respect for the safety engineer's ability to manage effectively the functions necessary to prevent accidents with their consequent human and economic losses. My efforts, and those of your Executive Committee, will be directed to this end but, as a member of the Society, you bear an equal responsibility to yourself and your chapter to help create this "image," because the end result will be to open greater opportunities in compensation and position for safety engineers. As members we can help achieve the goal by working on those factors which are influential in creating the desired "image."

At the chapter level, for instance, such factors include the qualifications and caliber of chapter members, the appropriateness and value of meeting programs, the business-like conduct of meetings and the relations of the chapter with the community.

On the national level, aid to chapters can be increased through the activities of the Executive Committee's standing and special committees, assisted by the region vice presidents. With reference to these "aids," I want to make it clear that I am not referring to "tools of the trade" such as posters, handouts, etc., for use by members in company safety programs; but rather, I have in mind a public relations pamphlet, a proposed program for a college safety course, a Junior Achievement safety program, a procedure for handling safety legislation in government and other materials of this nature.

One major change which I propose to institute is in the composition of the standing and special committees. Heretofore, an attempt has been made to appoint to each committee a member from each region, which may have merit in providing broad geographical representation but which, I feel, does not make for effective operation. Transportation and budget limitations preclude frequent meetings and necessitate transacting committee business by mail, with possibly a meeting prior to each Executive Committee meeting if enough committee members are available.

My proposal to improve committee efficiency is to appoint committee chairmen by region and allow them to staff their committees with qualified members from their respective regions, thus enabling the committees to meet more frequently. Committee members will be selected by committee chairmen in consultation with their region vice presidents. It will not be required that committee members attend Executive Committee meetings but this is a requisite for acceptance of committee chairmanships.

It will be the primary responsibility of the first vice president of the Society to keep informed on the progress of committee projects and to offer advice and counsel on problems.

The responsibility for the future of the American Society of Safety Engineers will depend, not only on its leadership, but also on every member who, through dedication to the objectives of the Society and through personal professional deportment, will reflect the character of the Society and thus help earn an ever-increasing respect and regard for the profession of safety engineering.

George L. Gorbell

GEORGE L. GORBELL, PRESIDENT
AMERICAN SOCIETY OF SAFETY ENGINEERS

William W. Allison, supervisor of safety engineering for the Bettis Atomic Power Div., Westinghouse Electric Corp., has been in safety work since 1937 and with Westinghouse since 1949. He joined the Society in 1942 and is a member of the Western Pennsylvania Chapter. This article is his first for the Journal.

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SAFE AND UNSAFE USE OF RUPTURE DISCS

AND THE EFFECTS OF TEMPERATURE ON RUPTURE PRESSURE

BY WILLIAM W. ALLISON

ADVANCED TECHNOLOGY has rapidly increased the needs for higher pressures and temperatures and, consequently, the more common use of rupture discs. These tiny, dime-sized relief devices have answered effectively the problem of providing a non-leaking high pressure relief device that can be installed in a limited space. However, some serious hazards involved in the improper selection and use of rupture discs too frequently have been overlooked.

Boiler and Pressure Vessel Codes correctly require that all pressure vessels be equipped with an ASME (UG-129 and 133) approved pressure relieving device [1]; that the pressure setting of relief devices must not exceed the maximum allowable safe working pressure (MAWP) of the vessel; and that the setting must be stamped on the relief device. To meet these codes, vessels should be designed to meet an MAWP of 20 to 25 per cent above anticipated operating pressure and to use a rupture disc with a burst rating not exceeding the MAWP so that one can safely utilize the vessel to meet his operating requirements. Many of the rupture discs in use today do not have the bursting pressure stamped on them. The reason is very simple. In many cases, there simply isn't room for the old style large flange type rupture disc holder which allows the use of stamped ratings on the disc.

Carefully conducted safety engineering inspections

have revealed that basic safety, as well as good code requirements, have been violated by using unstamped discs. Investigations have proved that many of these unmarked rupture discs actually had bursting pressures far above the design MAWP of the vessel. In some cases, single unmarked discs in use were actually found to have bursting pressures 200 per cent of the MAWP of the vessel. Other cases have been found where two discs inadvertently were used intead of one. Such human errors can result in catastrophic explosions. Errors of this type readily can be detected and avoided if the rupture pressure is stamped on a tab affixed to each disc. Inspection of a tabbed disc provides simple and positive evidence of the pressure rating of the relief device.

Figures 1 and 2 depict two safety heads using rupture discs, with tabs affixed, which meet code requirements. Figure 1 illustrates a standard bolted flange type safety head (sizes ½″ to 16″) that can be used wherever space permits. The safety head illustrated in Figure 2 is a new special union-type safety head which can be used wherever space does not permit the use of the larger bolted type. These are the only types of rupture disc devices that actually meet code requirements. The use of older style union-type safety heads, commonly used on autoclaves which do not permit the use of discs with ratings (burst pressure) stamped on a permanently affixed tab, should be discontinued.

Another hazard which has been found to be rather commonly overlooked, in the use of rupture discs, is the selection of the wrong material and the wrong temperature rating.

The effect of elevated temperatures on the bursting pressure of rupture discs is quite marked and varies considerably with the type of material the disc is made of. The table on page 52 (Figure 3) has been prepared to illustrate this point. Figures shown are in per cent of rupture pressure at room temperature of 72 F.

To determine the rupture pressure at any desired temperature, ranging from room temperature to the highest recommended temperature, refer to Figure 3 and multiply the rated rupture pressure by the percentage factor indicated for the particular metal involved. For example, to determine the rupture pressure at 500 F of a stainless steel disc rated 3000 psi at 72 F, simply multiply 3000 psi × 0.69 = 2070 psi at 500 F.*

If the rupture pressure required is known at any given temperature and it is desired to establish the rating at 72 F, divide the percentage factor indicated in the table into the known pressure rating. For example, to determine the rupture pressure at 72 F of an Inconel rupture disc that is rated at 3000 psi at 500 F, divide 3000 psi by 0.92 = 3190 psi at 72 F.

It is obvious from the above two illustrations that, while an Inconel disc only changes its relieving pressure by 190 psi with 428 degrees change in temperature, the stainless steel disc changes the pressure at which it will release by 1030 psi.

It is a rather common practice for engineers to specify a rupture disc that has bursting pressure and temperature ratings the same or somewhat above the MAWP and temperature of the autoclave or system the rupture disc is supposed to protect. This seems logical enough on the surface but, actually,

**It should be noted that this reduction in bursting pressure corresponds to the reduction in working strengths of pressure vessel materials with increasing temperatures.*

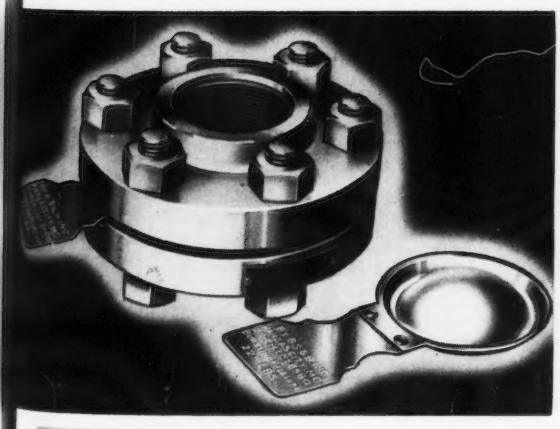


Figure 1—Standard bolted flange type autoclave-pressure vessel rupture disc with tab affixed.

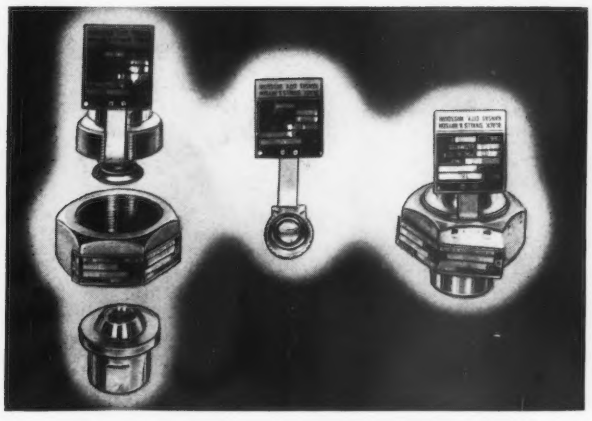


Figure 2—New union type safety head with tab, for use when space does not permit larger bolted type.

the rupture disc very rarely sees the operating temperature of the system. Field inspections and actual temperature readings indicate that the disc normally sees a temperature far below the temperature in the system. In most cases it sees room temperature or about 72 F. If a stainless steel rupture disc rated at 2070 psi at 500 F is used and the disc only sees 72 F, it will not rupture and release excess pressure until the pressure rises 1030 degrees and reaches 3000 psig. Actual experience indicates that commercially available rupture discs burst at the rating stamped on them with generally less than a two per cent variance. Some rupture disc authorities have recommended conservatively that complete assurance that a rupture disc will not burst and release valuable contents of a vessel is best achieved by use of a disc with a bursting pressure 50 per cent above normal operating pressure. It has not been too uncommon to find that the design and/or operating engineer misinterpreted this statement to mean that a rupture disc 50 per cent above the MAWP of the vessel or high pressure system was recommended. This could result in the installation of a stainless steel rupture disc rated at 3000 psi at 500 F on an autoclave, compressor or other high pressure system which has a MAWP of 2070 psi at 500 F. The autoclave or other high pressure system could then reach a pressure of about 4350 psi and could rupture before the disc would rupture. If Inconel discs are used and the same error is made, the Inconel disc would rupture at 3190 and save the vessel.

As the temperature of the rupture disc at any given time normally will not be known and, since there is very little variation in the rupture pressure of Inconel discs with changes in temperature, it follows that the use of Inconel discs will allow disc rupture within about 6 per cent above MAWP of the vessel it is protecting if it is rated at the MAWP and MAWT up to 600 F. A stainless steel disc might not rupture within 32 per cent above MAWP of the vessel it is supposed to protect. On the other hand, since discs which are mounted in a safety head connected to an outlet (from a few inches to a few feet long) normally see room temperature, the use of a disc rated at 72 F and at (or below the) MAWP will rupture within 4 per cent of the MAWP.

When discs have higher temperature ratings than those which the disc normally sees, there is likelihood that they may fail to protect the vessel unless they are of a material such as Inconel whose bursting pressure is not drastically affected by temperature.

When discs have temperature ratings of about 72 F, then stainless steel, Inconel, Monel, nickel or other appropriate materials can be used safely.

Where heat of reaction temperatures and pressure are involved, more safety is provided with a disc metal that is most readily and most drastically affected by temperature increases. Of course, no relief device can protect vessels against exothermic reactions that result in violent explosions or detonations.

In every case extreme care must be taken to assure that the relief device is not defeated by placing automatic pressure regulators, valves, cooling coils, etc., between the pressure system and the relief device. Anything that possibly can prevent the relief device from seeing any temperature or pressure rise in the vessel sooner or later leads to violent failure of the vessel.

REFERENCES

1. "Rules for Construction of Unfired Pressure Vessels," Section VIII, *ASME Boiler and Pressure Vessel Code* (1959 ed.; New York: American Society of Mechanical Engineers).

2. Myers, J. F., mimeographed technical data release (Kansas City, Mo.: Black, Sivalls and Bryson Inc.).

3. Actual operating experiences.

FIGURE 1
Approximate Effects of Elevated Temperatures on the Rupture Pressure of Discs as Compared to 100% at 72F 2, 3.

Temperature Degree F	Inconel %	Stainless Steel %	Monel %	Aluminum %
72	100	100	100	100
100	99	96	97	98
200	95	85	91	88
300	94	76	87	—
500	94	69	82	—
600	94	68	81	—
700	93	—	78	—
800	92	—	75	—
900	91	—	—	—

BY PHILIP J. BAILEY

YUGOSLAVIA looks at SAFETY

During the months of January and February, 1960, an Industrial Safety Study Team from Yugoslavia toured the United States. For a period of five weeks they observed and studied all phases of industrial safety in chemical plants. Their visit included trips to the operations and laboratories of Charles Pfizer and Company Inc., Union Carbide Plastics Company, Monsanto Chemical Company, Davision Chemical Company, and Walter Kidde and Company Inc.

THE OVERALL PURPOSE of this visit to the United States was to learn about the duties and responsibilities of safety engineers in industrial plants. These Yugoslavians know how to go about making safety inspections and how to make recommendations for safety improvement. They were interested in the scope of supervisory authority for the maintenance of safety rules.

They wanted to know about teaching and training methods for workers. They asked to observe the American industrial approach to the encouragement and enforcement of safety programs. They desired to listen to the safety lectures, look at the safety motion pictures, see the demonstrations we use in educating our workers, and write down all that they saw and heard, including our approach to disciplinary action for repeated safety rule offenders.

This Yugoslavian Study Team visited our country under the sponsorship of the International Cooperation Administration of the United States Government. The expenses for the trip were borne entirely by the Yugoslav Government. The official United States identification of this team was Project 58-90260.

Project 58-90260 was comprised of eleven Yugoslavians. They were engineers, supervisors, technicians and a doctor. All of these people were employed in or by Yugoslavia's chemical industry. The team leader was Dr. Nikola Milution Stanojlovic. He was chief of the medical and safety services of the Tuzla Soda Factory in Lukavac. A tall man of middle years, he seemed to be vigorous, sincere and intelligent. In addition the team included eight other men and two women. Each one of them was responsible for some phase of safety or health, or both, in Yugoslavian industry.

I met Project 58-90260 on the morning of January 14, 1960, when they visited Kidde's operations in Belleville, New Jersey, to learn about fire extinguishing methods and equipment, fire detection and safety. Accompanying them was A. E. Laurencelle of the Processes and Techniques Studies Branch, International Cooperation Administration, Washington, D. C. He was the manager of Project 58-90260. Also with the group were Mr. and Mrs. Dusko Duisin, the interpreters for the team. They had charming personalities and spoke a clear American-English. All of the team were cheerful, curious, animated, excited.

It became my pleasure and honor to be the first American safety engineer to speak to this group about American industrial safety. Our International Division had approached me several weeks before, telling me about this impending visit of the team to our operations. I was asked if I would talk to them about our accident prevention progarm. I readily agreed—give any safety man an audience and he will talk!

However, a few days before the Yugoslavians arrived I found I had become nervous about our forthcoming meeting. I have addressed a number of audiences on safety and accident prevention topics. I am afraid I could deliver some of my lectures in my sleep. I am even aware that some parts of my audiences have dozed while listening. That has never made me timid about talking safety. But the thought of talking through an interpreter bothered me. What would he do? Hold up his hand and say "stop" after every statement? The thought was disquieting. I am the type of speaker who gains his momentum as he goes along—low, second, high and over-drive!

On that morning, Mr. Duisin, the interpreter, put me quickly at ease. He asked me to deliver my lecture at a natural pace, just as though I was speaking to a group that understood English. He would trans-

Philip J. Bailey, safety administrator for Walter Kidde and Co., began his safety career some 20 years ago, joined the Society in 1950 and is a past treasurer of the New Jersey Chapter. Author of many safety articles, this is his third to be published in the *Journal*, the others having appeared in 1956 and 1959.

The author checks his Serbian translation of "Tell-Show-Test-Check" as he addresses Project 58-90260. (Note dominoes to right of Mr. Bailey. They are part of another of his demonstrations.)

yugoslavia looks at safety *continued*

mit a translation of my remarks through a small but efficient amplifier directly to the button type earphones worn by all members of the study team. They would hear my story just as fast as I related it. And I would not hear, nor be distracted by, the transmission of the interpreter.

He told me that any member of the team desiring to ask a question would indicate this by raising a hand. I should stop. Mr. Duisin would repeat the question in English and my reply would be translated as I spoke. Simple!

When first I had been requested to speak by my company I realized how little I knew about Yugoslavia. I knew that it was a totalitarian state under Communist rule and with only one political party. I knew that its industries and raw resources and railroads were nationalized. I also knew that it had repudiated the Kremlin's authority and had been expelled from the Cominform. It was a Communist country immediately outside of the Iron Curtain. I did not know anything about its size, its natural resources or its manufacturing.

A little research in my son's school books surprised me. Yugoslavia was bigger than I had realized. It is about the same size, maybe a little larger, than a combined New York and Pennsylvania. It has approximately 75 per cent of the population of those two states. Yugoslavia mines coal, bauxite, iron, copper, chrome, lead, zinc, antimony and salt. It produces some petroleum. It manufactures chemicals and pharmaceuticals, nitrogen and nitrides, paints, lacquers, synthetic fibers, leather, textiles, paper and paper products, metals and metal products. It processes food. *It has almost a million workers in nationalized industries.*

As I looked at the study team around the large table in our conference room that morning, its members did not appear to be any different than those of many other groups I had seen in the same place. They looked like professional people with a slightly continental air.

I began by telling them that *safety integrated into production* is the American approach to accident prevention. We knew from experience that safety had to be a part of production. Therefore, we treated safety in the same manner we treated product design, quality control, job methods, waste control. All of these, and more, are parts of the production technique. The American concept of industrial accidents and injuries considers them to be nonproductive phenomena, costing money, wasting lives, material, products and time.

I then spoke to the team about job-training of new personnel—and additional training for transferred people to prepare them to recognize the inherent exposures which might exist in new jobs.

TRANSLATES KEY TRAINING WORDS

Ahead of time I had prepared some small cards, wallet size, for our guests. After I had distributed the cards I watched, holding my breath, while they scrutinized the four Serbian words: *KAZATI* (tell), *OBJASNITI* (show), *ISPITATI* (test), and *PROVJERITI* (check). I relaxed when I saw their smiles and increased interest. I silently thanked my secretary for her efforts in picking up these translations for me. I now knew they were sufficiently accurate.

I touched the words one by one, on my card. "*Tell* them about the hazards as you tell them about the job. *Show* them the hazards as you show all parts of the job. *Test* them—ask them questions to determine if they are remembering what you tell them. *Check* them—return at intervals to see that

they have learned and are following instructions."

I swung into the importance of top support for safety programs. "The foreman must be backed up." He must be upheld by those in command. Without that support the foreman is like a fisherman without a fishing line—he is like an airplane pilot without a plane—he is like a soldier without a gun. Those in command must *want* a safe operation before they can expect a safe plant. Posters on a wall can never make a plant or a people safe!

"We believe that the foreman or the supervisor is the most important figure in any organized safety effort. He is in constant contact with his people. He sets the example. He corrects the reckless. He maintains discipline. He takes aside and re-instructs workers who may be developing unsafe work habits. He creates the good attitude about safety by constantly showing his genuine interest in the welfare of the group."

DEMONSTRATES WITH KING-SIZE DOMINOES

A demonstration that drew interest was done with the aid of five large dominoes, twelve inches high, and dotted from double-one to double-five.

On the edge of each domino was a Serbian word. On the double-one, *OKOLINA* for "Environment." On the double-two, *LJUDSKI* for "Human Factor." On the double-three, *MECHANICKI* for "Mechanical Factor." On the double-four, *NESGODA* for "Accident." On the double-five, *POVREDA* for "Injury." Again my resourceful secretary had come up with workable interpretations of the English words!

I placed the dominoes on the shelf in back of me, in a line, their edges to my audience. I touched each domino in turn.

"This one is the workpiece—the factory—the laboratory. Next to it are the human and the mechanical factors. The last two are the accident and the injury."

I tipped *OKOLINA*, or "Environment," and all of the dominoes fell, each one triggering the next one. I fished *POVREDA* from the pile, held it up.

"And in such a manner does the work-injury happen!"

Carefully I realigned all of the dominoes, then removed *LJUDSKI* and *MECHANICKI* from the number two and number three spots.

"If we control the human factor; guard against the mechanical factor . . ." I tilted the first domino again. It fell harmlessly; the last two dominoes remained standing. ". . . there can be no accident, no injury!"

A hand shot up and a question was fired. The interpreter turned to me. "Mr. Dimitri Cemerikic, a foreman of the plant Viskoza in Loznica, asks you how can the human factor, the mechanical factor, be always controlled?"

"We learn in part by experience," I told them. "The only good thing we ever get from an accident is experience. But we cannot afford to sit back and wait for that experience. We must anticipate the causes of accidents—of injuries—and take measures to guard against them."

I demonstrated safety equipment and safety clothing. I showed them samples of eye protection, head protection, footwear, gloves, aprons, coveralls, respirators and other personal protective eequipment that we use in our operations. They seemed to be impressed by the amount and variety of these items.

I explained to them about the thoroughness with which we physically examine new employes before they are hired. When we do reject a candidate employe because he does not meet our physical standards, we always advise the person about the reason for rejection. Sometimes we have been of service to such people by calling to their attention a physical condition not suspected until the medical examination uncovered it.

I told them that our physical standards did not

Group photo of the Yugoslavian Industrial Safety Study Team on the Walter Kidde and Company Proving Grounds as they prepare to participate in a fire extinguisher demonstration. In foreground, Dr. Nickola Milution Stanojlovic, team leader (wearing raincoat), is welcomed by Ralph P. Kinder of Kidde organization.

necessarily reject people with amputations, or even the loss of an eye. We were just more careful and exacting in placement of these slightly handicapped. And sometimes we found that these physical losses were not handicaps at all.

I stressed the importance of periodical re-examinations for employes who worked with or around chemicals, paints, solvents, dusts or any toxic material. This should be done to make certain that all safety controls are functioning. I also pointed out the importance of medically examining people returning from sick leave.

I told them about another important group of safety people—our methods engineers—who help to control the human and the mechanical factors by designing safety as well as efficiency into the devices, jigs and fixtures they formulate for production operations.

I related to the team an incident of some years ago when a worker on incentive rates ingenuously had blocked out one control of a small two-hand controlled press. He accomplished this by inserting a one inch bolt, three inches long, into the space in the machine above one of the hand controls. This made it possible for him to keep his right hand free to reach into the machine while his left hand operated the ram. Before his foreman could catch him he had pinched off the tip of a finger.

A methods engineer was assigned the task of stopping any further attempt to block out any controls on these small presses. He accomplished this very simply—by installing a timer in the electrical control box. Now these machines are arranged so that any attempt to block out a control will shut down the machine. And it cannot be started again until the foreman unlocks the control box and resets the timer.

EXPLAINS SAFETY ORGANIZATION

I explained to the Yugoslavian something about the typical American industrial safety organization. I used our own safety organization as a chart. This phase of our discussion aroused the most interest. They wanted to hear about the makeup and function of Safety Committees. They plied me with questions about the rank, status and scope of safety committees in industrial plants.

We have six safety committees at Kidde, including the General Safety Committee. I told them that in our organization these committees were all made up of management people but, in many American factories and laboratories, the safety committees contained some personnel who are not supervisors or foremen or members of management.

"It is more important," I told my visitors, "that the people on safety committees be sincere in their desire to promote and maintain a good safety standard, and have the vigor and stamina to persist in seeing that the standard is adhered to."

I described how each of our safety committees functioned in a different part of our operations. Our projects are complex: chemical, electronic, machine shop, press, assembly, engineering, research and development. Five of our safety committees function in these environments, monitoring the safety program. They refer to the General Safety Committee only those problems which cannot be resolved quickly because of cost, conflict or some other reason. The safety engineer coordinates the entire safety program, including the work of the safety committees, and reports to top management.

PLANS INCLUDE MANY VISITS

After the meeting was over I had an opportunity to discuss with Mr. Laurencelle the agenda of Project 58-90260 during its stay in the United States. He told me that plans for the team included visits to and discussions with industrial associations, engineering colleges, government bureaus, trade associations, safety councils, underwriters of industrial fire and casualty insurance, municipal fire and police departments, safety equipment manufacturers and other organizations concerned with chemical and industrial safety.

Mr. Laurencelle added that production and refinement of chemicals has today become Yugoslavia's fastest growing industry. When the study team returned to Yugoslavia, it would prepare a report detailing impressions and observations of what it had seen and heard in the United States regarding chemical and industrial safety. This report will be distributed throughout Yugoslavian industry, along with recommendations for the broadening of safety effort in industry and the reduction of work injuries.

When I said goodbye to the study team as it boarded the bus taking it to New York, I felt a reluctance about seeing it leave. These people from a far country had been like intelligent sponges, absorbing safety information as I had never seen it absorbed before. Their endless questions still rattled in my head. I felt inadequate. I would have liked to join them on their safety tour of the United States —listened as they listened—looked as they looked —scribbled notes as rapidly as they did—continuously. They taught me one thing—the concept of safety is international. I hope I taught them something.

Appraising Safety Effectiveness

BY JOHN V. GRIMALDI, Ph.D.

John V. Grimaldi, Ph.D., is consultant for safety and plant protection, General Electric Co. He is first vice president of the Society, which he joined in 1945, and a Metropolitan Chapter member. A prolific and widely-published safety author, this is his third *Journal* article.

Nine principal cost items, typical of manufacturing operations, were studied statistically relative to four measures associated with safety performance. The data were taken from 17 varied businesses over a three year period.

It was indicated that in operating components where there is a fairly good control of all contingency costs, a generally good safety profile prevails.

Differences in safety performance appear to be indicated by differnces in severity rates and average severity, rather than the generally accepted frequency rate.

It appears possible to compute, from cost accounting data, a measure which indicates management effectiveness in controlling contingency costs and predicts safety experience.

THERE IS A NEED for more suitable measures of safety effectiveness. Management now is informed of safety progress by either injury rates or plant safety audits. However, zero rates can not indicate degree of performance and variations in the rates may be due to chance rather than effective accident control.

A measure that would alert managers to a gradual loss of accident control, could incite prompt corrective action before severe accidents occurred. To some extent plant audits provide this intelligence, but their value depends on many factors—e.g., the auditor's knowledge, attitude, available time, etc.—and so the reliability of such audits is questionable.

A complication in appraising safety effectiveness has been the logical question, "How much control is practical?" It is apparent, but unreasonable, that plant injuries can be eliminated by stopping work. So could a number of contingency losses which attend productive businesses. For example, machinery damage and increases in costs due to scrap, rework

TABLE I

REGRESSION COEFFICIENTS, STANDARD DEVIATIONS AND DEGREES OF FREEDOM

	Factor	Regression Coefficients With 5	Regression Coefficients Without 5
(1)	5*	.41	
	6	.40	.75*
	7*	—.55	—.55*
	8	.01	—.04
	9	.16	.11
	10	.08	.05
	11	—.13	—.22*
	a	—.0295	—.0222
	‡s	.1289	.1315
	‡‡d/f	9	10
(2)	5	.73	
	6	—.59	.04
	7	.42	.41
	8	.46	.35
	9	—.13	—.21
	10	.14	.07
	11	.07	—.09
	a	—.0065	.0063
	s	.2604	.2614
	d/f	9	10
(3)	5	.09	
	6	—.16	—.08
	7	—.59	—.59
	8	.17	.16
	9	.76*	.75*
	10	.80*	.79*
	11	.12	.10
	a	—.2079	—.2063
	s	.1182	.1126
	d/f	9	10
(4)	5	.59	
	6	.73	.38
	7	—.11	—.11
	8	.20	.26
	9	.67*	.71*
	10	—.12	—.08
	11	.25	—.29
	a	—.0792	—.0862
	s	.2172	.2114
	d/f	9	10

*indicates the regression coefficients of major importance
‡standard deviation from the line
‡‡degrees of freedom

TABLE II

"CORRELATION" MATRIX

	6	7	8	9	10	11	5	1	2	3	4
6	9993										
7	1074	9677									
8	—0030	0150	9856								
9	—2611	3814	—1566	8790							
10	—0072	0442	—0350	—2052	9163						
11	0006	0003	0030	—0454	0052	9993					
5	8882	—0453	—1192	—2709	—0666	—2153	9996				
1	7182	—4812	—0747	—3018	—0090	—2210	7699	9968			
2	0989	3267	3898	—1028	1130	—0832	1476	—	9987		
3	—2935	—2452	0075	2680	5373	0721	—3337	—	—	9302	
4	1923	1732	1443	4763	—2395	—3275	1325	—	—	—	9953

appraising safety effectiveness *continued*

and complaints, among other operating charges, are the result largely of either an improper operational procedure or a failure of personnel to carry out a proper procedure. So too, are disabling injury accidents.

Control, in any case, would appear to be a function of how ably managers persuade subordinates to meet responsibilities fully. A valid means for appraising accident control performance, independent of injury data, could be expected to spur performance and foster a climate that would advance safety achievement.

One approach to such an objective might be to appraise managerial effectiveness in controlling contingency costs. Data are readily available in typical cost accounting systems. The appropriateness of such an attempt appears justifiable. Disabling injuries (the conventional target of accident prevention

TABLE III

AVERAGE FACTOR SCORES (Three-year Period—14 Variables)

VARIABLES		FACTORS										
			SAFETY			MAN HOURS	CONTINGENCY COSTS					
		Z_1	Z_2	Z_3	Z_4	Z_5	Z_6	Z_7	Z_8	Z_9	Z_{10}	Z_{11}
SAFETY		(Gen. Saf. Factor)										
absenteeism	x_1	172	91	35	247							
days lost	x_2	1329	635	456	—538							
no. dis. injury	x_3	863	—340	—102	993							
tot. no. injuries	x_4	322	577	—742	—1014							
TOTAL MANHOURS	x_5					1730						
MANAGERIAL												
scrap	x_6						610	1280	385	—122	283	770
rework	x_7						618	—239	330	924	—775	37
direct labor	x_8						522	67	71	—272	57	—440
shop	x_9						450	—304	—166	301	—176	1330
work. comp.	x_{10}						501	—489	—711	692	—307	803
building maint.	x_{11}						617	163	—1030	—132	671	—445
equipment maint.	x_{12}						370	22	—179	136	321	184
sales	x_{13}						451	—264	—133	—260	—303	83
complaints	x_{14}						802	627	1008	654	447	122

programs) are only one type of accident. Management oversights which precede their occurrence are also associated with such unwanted (accidental) operational results as: scrap, customer complaints and increased shop costs. Hence, a statistical intercorrelation may exist. This interesting possibility prompted an investigation of the feasibility of constructing such a measure.

For the first step in the research method, a number of cost accounting elements were selected. These were considered to be cost variables, controllable by management. They were: (1) scrap cost, (2) rework cost, (3) direct labor cost, (4) shop cost, (5) workmen's compensation*, (6) building maintenance, (7) equipment maintenance, (8) sales value, (9) complaint costs.

Several safety variables were considered: (1) absenteeism*, (2) severity rate—i. e., days lost and charged due to disabling injuries per million manhours, (3) frequency rate—i. e., total disabling injuries per million manhours, (4) total frequency rate—i. e., total minor and disabling injuries per million manhours.

Seventeen different businesses composed the experimental sample. They were: (1) motors, generators and synchronous condensers, (2) locomotives and car equipment, (3) control systems, motor starters and components, (4) capacitors, (5) distribution transformers, (6) steam turbines and generators, (7) TV receivers, (8) small electrical appliances, (9) home laundry equipment, (10) metallurgical products, (11) general purpose A.C. motors, (12) hermetic motors, (13) conduit products, (14) instrument products, (15) heavy military electronic products, (16) electronic tubes, (17) semiconductors.

Workmen's compensation and absenteeism were included in the contingency cost and safety variables respectively because these data were so easily obtainable and it was considered worthwhile to explore their value with respect to the study's objective. Neither proved to have any significance.

TABLE IV

COMPONENTS OF CONTINGENCY COST VARIABLES ON $\hat{Z}_1$

$\hat{Z}_1 = 0.72425\ Z_6 - 0.50519\ Z_7 - 0.22044\ Z_{11} - 0.0091230$

Component of	on $\hat{Z}_1$	
x_6	—384	scrap costs
x_7	553	rework costs
x_8	433	direct labor costs
x_9	178	shop costs
x_{10}	420	workmen's compensation
x_{11}	456	building maintenance
x_{12}	407	equipment maintenance
x_{13}	433	sales
x_{14}	228	complaint costs

Figures for each variable were obtained quarterly from these businesses for the three year period 1955-1957. The data then were converted to factors expressible as linear combinations. Contingency cost and safety variables were analyzed as given, as well as on an equivalent manhour basis. Using logarithms of the data facilitated this analysis.

The factor analysis summarization reduced the 12 *"safety variables"* (four variables for three years) to four *safety* factors, with little loss of information, since the criterion used was that the factors should retain 90 per cent of the original information when tested statistically. Similarly, the three manhours variables (one variable for three years) were reduced to one factor and the "contingency cost variables" were reduced from 27 variables (nine variables for three years) to six factors.

A step-wise linear regression technique was used to examine the possible relationships between var-

TABLE V

COMPONENTS OF CONTINGENCY COST VARIABLES ON $\hat{Z}_3$

$\hat{Z}_3 = 0.46623\ Z_9 + 0.69084\ Z_{10} - 0.1518250$

Component of	on $\hat{Z}_3$	
x_6	—13	scrap costs
x_7	—256	rework costs
x_8	—240	direct labor costs
x_9	—135	shop costs
x_{10}	—42	workmen's compensation
x_{11}	250	building maintenance
x_{12}	7	equipment maintenance
x_{13}	—482	sales
x_{14}	462	complaint costs

TABLE VI

COMPONENTS OF CONTINGENCY COST VARIABLES ON $\hat{Z}_4$

$\hat{Z}_4 = 0.54184\ Z_9 - 0.0623008$

Component of	on $\hat{Z}_4$	
x_6	—128	scrap costs
x_7	438	rework costs
x_8	—209	direct labor costs
x_9	101	shop costs
x_{10}	312	workmen's compensation
x_{11}	—134	building maintenance
x_{12}	8	equipment maintenance
x_{13}	203	sales
x_{14}	291	complaint costs

TABLE VII

INTERCORRELATION OF CONTINGENCY COST AND SAFETY FACTORS WITH MANHOURS REMOVED

	Z_6	Z_7	Z_8	Z_9	Z_{10}	Z_{11}	Z_1	Z_2	Z_3	Z_4
Z_6	.458									
Z_7	.1056	.998								
Z_8	.2959	—.0086	.993							
Z_9	.4130	—.0092	—.0214	.987						
Z_{10}	.1534	—.0034	—.0075	—.0124	.998					
Z_{11}	.5563	—.0123	—.0260	—.0363	—.0156	.976				
Z_1	.1530	—.7119	.0350	—.0533	.0852	—.0902	.637			
Z_2	—.0929	.3281	.4100	—.3226	.1133	—.0525	—.1817	.989		
Z_3	.0032	—.2339	.0682	—.0523	.4690	.0060	.4361	.0522	.941	
Z_4	.2135	.2086	.1554	.6186	—.2566	.3107	—.1618	—.0199	.0462	.981

appraising safety effectiveness *continued*

iables. In computing the regression analysis, the following equations resulted. (The Z's symbolize the mathematical result of the factor analysis of the safety and contingency cost variables.)

WITH MANHOURS

$$\hat{Z}_1 = -0.46215\ Z_7 + 0.74929\ Z_8 - 0.0055121$$

$\hat{Z}_2$ = (no significant relation)

$$\hat{Z}_3 = 0.46623\ Z_9 + 0.69084\ Z_{10} - 0.1518250$$

$$\hat{Z}_4 = 0.54184\ Z_9 - 0.0623008$$

WITHOUT MANHOURS

$$\hat{Z}_1 = 0.72425\ Z_6 - 0.50519\ Z_7 - 0.22044\ Z_{11} - 0.0091230$$

The equations for $\hat{Z}_2$, $\hat{Z}_3$, $\hat{Z}_4$, are the same with and without manhours, as can be seen from the fact that they are independent of Z_5 when manhours are included. The hat over the Z's ($\hat{Z}$) represents the estimated Z's as predicted by the analysis.

The regression coefficients, standard deviations and the degrees of freedom will be found in Table I. The correlation matrix is Table II. The diagonals are not unity because the means have been removed in the factor analysis process. Using the regression equations, the hypothesis that a relationship exists between contingency cost and safety factors can be tested and is substantiated. In applying the equations the coefficients of the regression lines are multiplied by the component factor scores (see Table III) of the corresponding factor. That is, in the case of Z_4 we would have:

$$\hat{Z}_4 = 0.54184\ (-122)\ (924)\ (-272)\ (301\ (692)\ (-132)\ (136)\ (260)\ (654)\ -62 =$$

The results are tabulated in Tables IV, V, VI. In brief, these are the findings.

TABLE VIII

INTERCORRELATION OF CONTINGENCY COST AND SAFETY FACTORS WITH MANHOURS

	Z_1	Z_2	Z_3	Z_4	Z_5
Z_5	.771	.147	—.339	.131	1.000
Z_6	.720	.098	—.300	.191	.889
Z_7	—.495	.315	—.201	.197	—.056
Z_8	—.068	.386	—.024	.136	—.117
Z_9	—.159	—.339	.006	.578	—.162
Z_{10}	.007	.103	.461	—.259	—.061
Z_{11}	—.222	—.082	.079	—.326	—.216

The regression analysis of the six contingency cost factors indicates that three (Z_6, Z_7 and Z_{11}), can be combined to give a *composite* that is highly significantly related to Z_1, which has been labeled the "general safety factor." (It is essentially a measure of severity. See Table III for the factor score.) The *composite contingency cost factor* shows a strong relationship to rework costs and to a slightly lesser extent all the other variables save shop and complaint costs. The complaint cost is only slightly related and an interesting aspect is the negative relation to scrap costs. The results seem to suggest that an effort to reduce one may adversely affect the other.

The second safety factor (Z_2) is not significantly related to the cost factors, but the third (Z_3), essentially a measure of average severity (i. e., the ratio of severity to frequency rates), is significantly related to two of the cost factors. The importance of this factor to the contingency cost variables is largest for complaint costs and it shows a strong negative relation to sales, a slight positive association with building maintenance and a negative relation with rework, direct labor and shop costs.

When the effect of manhours is removed, the four safety factors correlate with the cost factors as shown in Table VII. The multiple correlations of the safety factors, as predicted from the cost factors, are left effectively unchanged by the removal except for the general safety factor (Z_1). See Tables VII and VIII.

The general safety factor is highly correlated with the composite contingency cost factor and it has

TABLE IX

PREDICTED AND ACTUAL INJURY SEVERITY RATES (1957-58)

	Severity Rates		
Businesses Expected to Improve	1957	1958	
T. V. Receiver	145	135	
Steam Turbine and Generators	290	129	
Locomotives and Car Equipment	1226	107	
Home Laundry	1328	8	
Motor, Generator and Synch. Condensers	458	1406	X
Distribution Transformers	777	98	
Electronic Tubes	40	93	X
Heavy Military Electronic Equipment	508	46	
Measuring Devices	184	60	
Businesses Expected to Retrogress			
Small Electrical Appliances	363	598	
General Purpose Motors	248	83	X
Semiconductors	84	4	X
Metallurgical Products	116	409	
Hermetic Motors	44	68	
Conduit Products	104	0	X
$\bar{x}$:	394	216	
t:		1.258	
t:0.3,28		1.056	
t:0.2,28		1.313	

certain relationships with the contingency cost variables. One of the conclusions is that, if all of the variables are kept on a fairly low level—i. e., building maintenance costs, shop costs, etc.—while a tolerable rise in scrap costs is present, a generally good safety profile will prevail.

The quality of a measure which uses cost accounting data to appraise safety performance is not suggested by the study. That remains to be studied when an experimental measure is constructed. However, some notion of whether such a measure may be practical can be obtained from Figure 1.

This analysis predicts safety improvement or retrogression for 15 of the 17 businesses in the sample. The safety comparisons are in terms of standard severity rates, the principal component of the "general safety factor." Table IX gives the results of the prediction. Of the nine businesses expected to improve, all but two did. Of the six predicted to retrogress, three did not. Thus, 10 of the 15 (67%) performed as predicted. Although the sample was small and no statistical significance is indicated, the tendency for the businesses' severity rates to go in the direction predicted appears noteworthy. The importance of this observation seems enhanced somewhat by an examination of these businesses' directional progress in controlling fire losses. Using the predictions indicated in Figure 1, 11 out of 15 (73%) improved or retrogressed as expected. See Table X.

In general it can be said that:

1. Two of the four computed safety factors (Z_1 and Z_2) are found to have a relatively close relationship with several of the contingency cost factors. (Z_1) is the most prominent and may be considered the "general safety factor;" it inherently measures severity. (Z_2) essentially measures "average severity" (i. e., the ratio of the severity rate to the frequency rate).

2. Differences in the businesses' comparative profiles of safety performance appear to be explained by differences in their severity rates and average severity rather than the generally accepted measure, frequency rate. It is interesting that the severity rate and the average severity also are closely related to injury costs.

3. The regression analysis indicates several complex relationships which are less descriptive than the relationship between the general safety factor and the composite contingency cost factor. These are interesting, but do not help to clarify the contingency cost-safety relationship. They are reported below:

a. The second safety factor (Z_2) is not significantly related to the contingency factor.

b. The third safety factor (Z_3), essentially a measure of average severity, indicates a relatively strong negative relation to sales, lesser negative relation to rework, direct labor and shop costs. It is comparatively strongly related positively to complaint costs and less strongly related to building maintenance expense.

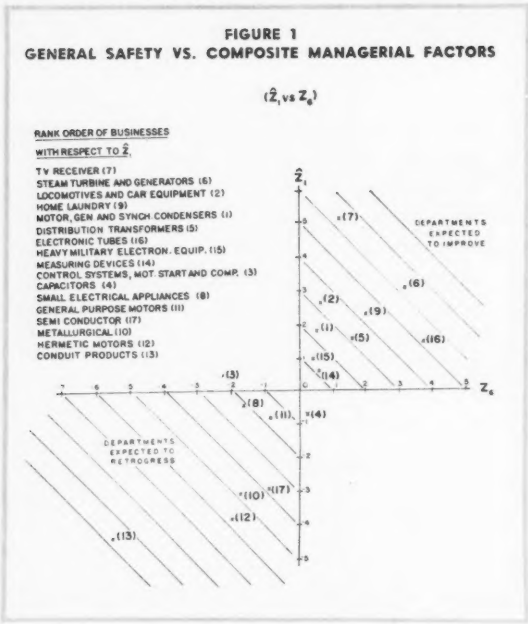
c. The fourth safety factor (Z_4), which is not in-

TABLE X

PREDICTED AND ACTUAL FIRE LOSSES (1957-58)

	Fire Losses (cents/$100 insurance)		
Businesses Expected to Improve	1957	1958	
T. V. Receiver	0.005	0	
Steam Turbine and Generators	0.026	0	
Locomotives and Car Equipment	0.030	0.002	
Home Laundry	0.004	0.027	X
Motor, Generator and Synch. Condensers	0.002	0.002	X
Distribution Transformers	0.198	0.007	
Electronic Tubes	0	0	
Heavy Military Electronic Equipment	0.067	0.003	
Measuring Devices	0.012	0	
Businesses Expected to Retrogress			
Small Electrical Appliances	0	0	X
General Purpose Motors	0.007	0.020	
Semiconductors	0	0.095	
Metallurgical Products	0.013	0.002	X
Hermetic Motors	0.008	0.011	
Conduit Products	0.002	0.125	
$\bar{x}$:	0.025	0.020	
t:	1.0073		
t:0.4,28	0.855		
t:0.3,28	1.056		

FIGURE 1
GENERAL SAFETY VS. COMPOSITE MANAGERIAL FACTORS



appraising safety effectiveness *continued*

herently descriptive of any one of the usual work injury experience measures, is relatively most strongly related positively to rework costs and to a lesser degree to complaint costs and sales. Negatively, it is most strongly related to direct labor costs and to a lesser degree to building maintenance and scrap.

DISCUSSION AND SUMMARY

The results broadly indicate that in a business where there is fairly good control of all contingency costs, a generally good safety profile will prevail. It appears that the better operation, from a safety point of view, keeps rework costs, direct labor costs, building and equipment maintenance costs, complaint and shop costs on a fairly low level while scrap costs may be tolerably high. (See Figure 2.)

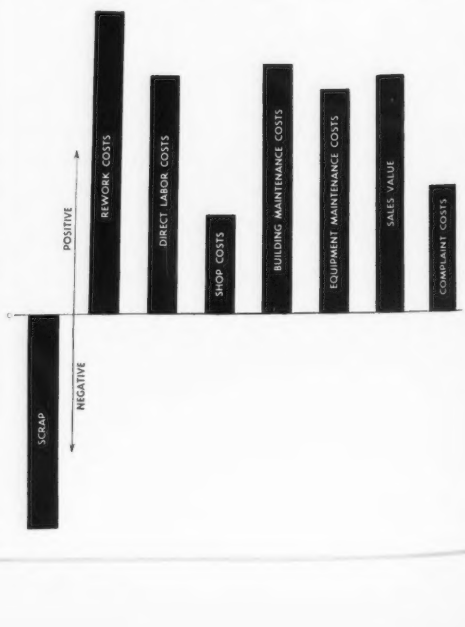
The inverse relationship of scrap costs to other costs, particularly complaint costs, suggests that an attempt to secure improvement in one may have an opposite effect on the other. This curious possibility may be interesting to study further.

The tendency for building and equipment maintenance costs to be low, where a good safety experience occurs, appears to be contrary to the theory of the case at first glance. Usually it is expected that a generous attitude toward maintenance expense exists in locations where good safety records are found. More careful consideration suggests, however, that the well managed operation (also the safer one) receives watchful preventive maintenance and thus keeps expenditures to a minimum.

The results indicate that sales are low in those departments where a better safety (in general, severity) record occurs. This would be expected when the injury and sales data are expressed only as totals for a time interval. But the data were examined on an equivalent manhour basis. Also, the safety factor is dominated by the severity variable which is influenced most heavily by the penalty charges and days lost for each injury, rather than the manhours of exposure. The comparison, therefore, is considered significant. The counter relationship between sales and safety effectiveness could be explained by the changing demand for better managerial performance that occurs as sales better or worsen. For example, with the exception of scrap, other managerial variables included in the study tend to be lower when a good safety profile exists. It would seem that managers apply themselves more assiduously when faced with declining sales and that the resultant tightening of control affects contingency losses broadly.

Computing, from management variables, a measure of accident control effectiveness appears promising even though statistically the ability of the "general contingency cost factor" to predict safety experience is not considered significant.

FIGURE 2
DEGREE OF RELATIONSHIP BETWEEN MANAGEMENT VARIABLES AND THE "GENERAL SAFETY FACTOR"



Abstracts SAFETY AND RELATED FIELDS

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ACCIDENT PREVENTION

Anyone for Industrial Roulette? J. E. O'Neil. *Safety Maintenance*, CXIX, No. 3 (March, 1960), pp. 10-11, 14. More than 90 per cent of industrial eye injuries could be prevented with use of safety eyewear; it is stressed that there are few if any industrial occupations that do not involve eye hazards either in themselves or as result of relationship to another occupation or to arrangement of machines that also involve hazards; facts given refuting common complaints against wearing of safety glasses.

Arbeitssicherheit bei der automatisierten Fertigung, O. Seeger. *Werkstatt u Betrieb*, XCIII, No. 3 (March, 1960), pp. 125-28. Accident prevention in automatic manufacture; discussion of technical problems concerning safe operation, organizational requirements, and physical and psychic problems; recommendations for accident prevention in machining and forming operations, and related materials handling.

Filters for Use during Welding and Similar Industrial Operations, British Standards Institution. *British Standard No. 679*, 1959, 17 pp. Standard relates to filters for eye protection, which may be wholly of glass, plastics surfaced with glass or wholly of plastics; requirements for quality, classification for density and color or circular filters for gas welding, thickness and optical uniformity; tests for permanence, resistance to heat and moisture and for flammability; recommendations for grades of filters to be used for different types of welding.

Industrial Trucks Designed for Safety, O. S. Carliss. *Safety Maintenance*, CXIX, No. 2 (February, 1960), pp. 18-19, 22-23, 26-27. New safety designs include better lifting mechanisms, speed controls, brakes, better grouping of controls to reduce operator fatigue and automatic transmissions; specific designations used on trucks for general purpose and hazardous use for fire safety; revised Safety Code suggested as valuable literature for users; proper maintenance and supervision of operating rules stressed.

Loss Prevention through Accident Prevention, G. A. Riley. *Modern Castings*, XXXVII, No. 6 (June, 1960), pp. 65-72. Description of accident prevention program at American Brake Shoe Co., New York; two case histories show vast difference in compensation values of years ago and today; charts, photographs and other illustrations show features of good accident prevention program and of bad practices.

New Practices in Supply and Distribution of Electricity in Oil Refineries, H. Stolpp. *Federation of European Petroleum Equipment Manufacturers Congress*, Paris, June, 1959, pp. 249-60. Safety requirements for power supply system; requirements of supply system; requirements of refinery distribution system; automatic switchgear; high speed diagrams of automatic control system (in English, French and German).

Safety Ideas that Paid Off, D. G. DePugh. *Pipe Line Industry*, XII, No. 1 (January, 1960), pp. 41-42. Ways of improving safety conditions during construction of pipe lines by modifying machinery and equipment; safety through innovations on shot-blast machines, cranes, coating applicators, tractors and double-jointing systems.

Safety Management in Electrical Wire and Cable Plant, P. Contardo. *Wire and Wire Products*, XXXV, No. 7 (July, 1960), pp. 866-68. Methods and tech-

niques used in many successful programs to achieve maximum efficient production with minimum injury to personnel and minimum damage to equipment, machinery, structures and material.

Safety Ring Guards against Accidents. *Plant Engineering*, XIII, No. 12 (December, 1959), p. 122. Ring guard sensing device, designed by Liberty Mutual Insurance Co. for Watchbands Inc., has pneumatic construction which prevents machine operation if worker's hands or fingers are in danger zone; schematic diagram and description of operation.

Shock Hazards of Electric Currents, A. R. Morse Jr. *Engineering Journal*, XLII, No. 11 (November, 1959), pp. 50-54. Electrical and physiological effects of electric shocks; "Let-Go" current; exposure over 80 ma can cause instantaneous death by fibrillation; 1/100 second of contact may be fatal; factors of resistance or of "total body resistance" are contact resistance, resistance proper of body and skin resistance; complete changeover to three-prong, grounded chasis 120-v system is recommended.

Statistical Model for Evaluating Reliability of Safety Systems for Plants Manufacturing Hazardous Products, L. B. Kahn. *Technometrics*, I, No. 3 (August, 1959), pp. 293-307. Technique for determining probability of failure of plant manufacturing hazardous product such as chemical plants and petroleum refineries; mathematical model developed can assist in proper selection of plant hazard control systems and provide means for economic evaluation of incremental risk protection; example using simplified plant given.

Vypocet a bezpecnost pri provozu parnich kotlu, P. Bettzieche. *Hutnicke Listy*, XIV, No. 7 (December, 1959), pp. 1169-71. Safety calculations for service of steam boilers; recommendation that safety factor be applied to service and temperature as well as to stress; momograph which enables safety to be expressed in terms of those parameters; time-safety values provide more exact concept of service life of unit than mere stress-safety values; results suggest that lower operating temperatures may permit operation at higher loads, while higher operating temperatures may necessitate greater caution in design of power plant equipment.

Why Grounding Pays, W. J. Neiswender. *Plant Engineering*, XIII, No. 7 (July, 1959), pp. 88-90, 176. Review of various methods and equipment for grounding electrical circuits to keep voltage confined and protect personnel; illustrations of circuit diagrams; best methods described.

INDUSTRIAL HYGIENE

Occupational Dermatitis: Its Cause and Cure. *Safety Maintenance*, CXIX, No. 2 (February, 1960), pp. 43-46. Causes divided into four groups: physical and mechanical agents, chemicals, botanical hazards and biological agents; each discussed; preventive and protective measures; suggested safeguards for employes listed.

Safety Limits of Hazardous Materials. *Safety Maintenance*, CXIX, No. 1 (January, 1960), pp. 33-35. Tables of threshold limit values for various gases and vapors, toxic dusts, fumes and mists, and mineral dusts adopted at American Conference of Governmental Industrial Hygienists, April, 1959; values represent exposure for repeated normal workdays.

NOISE CONTROL

Protection against Noise, F. Odend'Hal. *Mass Production*, XXXVI, No. 3 (March, 1960), pp. 110-12. Noise protection in industrial activities; noise effects on human hearing, work performance and spoken communication; effectiveness of wall or door designed to protect occupants of one room from noise in adjoining room, known as "sound transmission loss;" transmission loss achieved by various wall designs, with effect of materials expressed in terms of wall surface weight is shown.

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NUCLEAR SAFETY

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INDEX TO VOLUME V

JOURNAL OF THE AMERICAN SOCIETY OF SAFETY ENGINEERS

References are to volume number and page. Page numbers in the various issues are as follows: pages 1-16, February, 1960 (Number 1); pages 17-32, May, 1960 (Number 2); pages 33-48, August, 1960 (Number 3); pages 49-64, November, 1960 (Number 4).

A

Abstracts—Safety and Related Fields. *V:15, 31, 63*
Accident Prevention Committee of the Edison Electric Institute, The. *V:25*
Accident Statistics: *see Statistics*
Age, Safety Comes of. *V:3*
Allison, William W., *author. V:50*
Appraising Safety Performance. *V:57*

B

Bailey, Philip J., *author. V:53*
Black, James B., *author. V:29*
Blackman, A. C., *author. V:5*
Brunig, Winchester D., *author. V:9*

C

Challenge of technological advances, *editorial. V:17*
Changing Nature of the Work Force, The. *V:18*
Clague, Ewan, *author. V:18*
Committee on Membership Services, Report of the Special: *Today's Safety Engineer in Industry, Business and Government. V:34*
Computation of Construction Work Injury Costs. *V:9*
Construction Work Injury Costs, Computation of. *V:9*
Costs, Computation of Construction Work Injury. *V:9*
Cooperation, The Force of Voluntary. *V:11*

D

DeReamer, C. Russell, *author. V:21*
Dunne, John B., *author. V:3*

E

Edison Electric Institute, The Accident Prevention Committee of the. *V:25*
Editorials:
Gorbell, George L. (Society objectives) V:49
Jones, John F. (nature of professionalism) V:1; (challenge of technological advances) V:17; (importance of status survey) V:33

F

Force of Voluntary Cooperation, The. *V:11*
Frequency rates: *see Statistics*

G

Glass, More about Impact Tests on. *V:29*
Gorbell, George L., *editorial. V:49*
Grimaldi, John V., *author. V:57*

I

Impact Tests on Glass, More about. *V:29*
Importance of status survey, *editorial. V:33*
Injuries, Take into Account the Minor. *V:2*
International Labor Organization, The. *V:5*

J

Jones, John F., *editorials. V:1, 17, 33*

M

Marconi, E. Peter, *author. V:34*
Mason, Charles D., *author. V:2*
Membership Services, Report of the Special Committee on: *Today's Safety Engineer in Industry, Business and Government. V:34*
Minor Injuries, Take into Account the. *V:2*
More about Impact Tests on Glass. *V:29*

N

Naquin, Arthur J., *author. V:25*
Nature of professionalism, *editorial. V:1*
Nature of the Work Force, The Changing. *V:18*

O

Objectives, Society, *editorial. V:49*
Organizations:
Accident Prevention Committee of the Edison Electric Institute, The. V:25
International Labor Organization, The. V:5
Our President Speaks on Safety: *see Editorials*
Our Society Must Prepare Today for Tomorrow. *V:21*

P

Performance, Appraising Safety. *V:57*
Prepare Today for Tomorrow, Our Society Must. *V:21*
President Speaks on Safety, Our: *see Editorials*
Professionalism:
Challenge of technological advances, editorial. V:17
Importance of status survey, editorial. V:33
Nature of professionalism, editorial. V:1
Our Society Must Prepare Today for Tomorrow. V:21
Safety Comes of Age. V:3
Today's Safety Engineer in Industry, Business and Government. V:34

R

Report of the Special Committee on Membership Services: *Today's Safety Engineer in Industry, Business and Government. V:34*
Romney, George, *author. V:11*
Rupture Discs, Safe and Unsafe Use of. *V:50*

S

Safe and Unsafe Use of Rupture Discs. *V:50*
Safety Abstracts: *see Abstracts-Safety and Related Fields*
Safety Comes of Age. *V:3*
Safety Engineer in Industry, Business and Government, Today's. *V:34*
Safety, Yugoslavia Looks at. *V:53*
Severity rates: *see Statistics*
Society Must Prepare Today for Tomorrow, Our. *V:21*
Society objectives, *editorial. V:49*
Statistics:
Appraising Safety Performance. V:57
Changing Nature of the Work Force, The. V:18
Computation of Construction Work Injury Costs. V:9
Today's Safety Engineer in Industry, Business and Government. V:34
Survey: *Today's Safety Engineer in Industry, Business and Government. V:34*

T

Take into Account the Minor Injuries. *V:2*
Tests on Glass, More about Impact. *V:29*
Today's Safety Engineer in Industry, Business and Government. *V:34*

V

Voluntary Cooperation, The Force of. *V:11*

W

Work Force, The Changing Nature of the. *V:18*

Y

Yugoslavia Looks at Safety. *V:53*

AMERICAN SOCIETY OF SAFETY ENGINEERS

Membership Information

THE American Society of Safety Engineers has established the following classifications of active membership.

ASSOCIATE MEMBER—To be eligible as Associate Member an applicant shall be at least twenty (20) years of age and

a. Shall have a degree in engineering from a college or university whose curriculum is accredited by the Engineers' Council for Professional Development or shall have legal registration as a professional engineer and, in addition, shall be engaged in safety engineering with at least one (1) year's experience, no time being credited to this one (1) year unless at least fifty (50) per cent of the time was devoted to safety engineering, or shall have supervision over the safety engineering function of his organization; or

b. Shall have a college degree other than that specified in "a" above and, in addition, shall be engaged in safety engineering with at least three (3) years' experience, no time being credited to this three (3) years unless at least fifty (50) per cent of the time each year was devoted to safety engineering; or

c. In lieu of a college degree, shall be engaged in safety engineering with at least five (5) years' experience, no time being credited to this five (5) years unless at least fifty (50) per cent of the time each year was devoted to safety engineering.

MEMBER—To be eligible as a Member an applicant shall be at least thirty (30) years of age, shall have the qualifications required for Associate Membership and also shall have (5) years' experience in addition to that required by and of a type defined in the subsection of the requirements for Associate Member which is applicable to him.

FELLOW—To be eligible as a Fellow, a Member shall be nominated upon the unsolicited recommendation of three (3) other Members, shall be at least forty (40) years of age, shall have been a Member for at least thirteen (13) years, and shall have been engaged in safety engineering for at least twenty (20) years, during at least five (5) years of which he shall have been in responsible charge of the safety engineering function of his organization. In addition, he shall have made an outstanding contribution to the safety engineering profession. Recommendations of candidates for the Fellow classification, along with substantiating data, shall be sent to the Secretary of the Society, who shall submit such recommendations and substantiating data to the Committee on Membership. The Committee on Membership shall report its findings to the Executive Committee for action. Fellows shall be elected by a majority vote of the Executive Committee.

AFFILIATE MEMBER—To be eligible as an Affiliate Member an applicant

a. Shall be at least twenty (20) years of age and shall be engaged in safety engineering with at least one (1) year's experience, no time being credited to this one (1) year unless at least fifty (50) per cent of the time was devoted to safety engineering; he may remain in this classification while qualifying for Associate Member or Member Classification; or

b. Not being engaged in safety engineering, shall be at least twenty-five (25) years of age and shall have pursuits, attainments in accident prevention, or practical experience, extending over a period of at least three (3) years, which shall qualify him to cooperate with members of the Society and to render service to the Society.

for additional information write to

The American Society of Safety Engineers
5 North Wabash Avenue, Suite 1705
Chicago 2, Illinois

(or contact your local chapter)

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